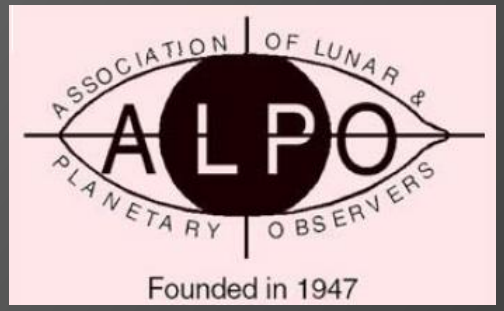

THE ALPO SATURN SECTION

PROGRAMS AND RECENT OBSERV ATIONS

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Value of Amateur Planetary Observations

- Complete freedom to observe whenever desired & for extended periods of time.
- Standardized systematic observations produce long-term continuous records of solar system phenomena that can be passed on to professional astronomers.
- Earth-based monitoring by amateurs of changing atmospheric features on planets like Saturn have often helped professionals select targets for high-resolution spacecraft imaging.
- In addition to systematic, simultaneous visual work, observers routinely produce excellent digital images at different wavelengths of light that are useful to professional astronomers.
- The ALPO serves *to encourage and coordinate regular, systematic investigations of the Sun, principal planets, and other members of our solar system with instrumentation readily available to amateur astronomers.*

Suggested Instrumentation for Observing Saturn

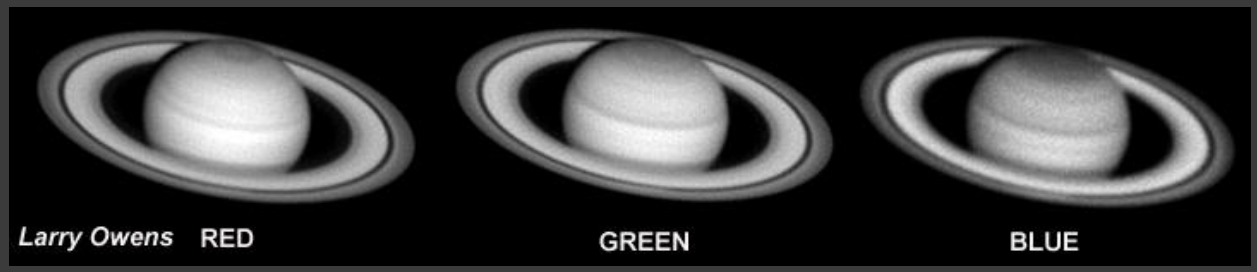
- Telescopes with excellent, precisely-aligned optics.
  - ✓ 10.2 cm (4.0 in) or greater for refractors.
  - ✓ 15.2 cm (6.0 in) or greater for Newtonian reflectors and catadioptrics.
  - ✓ Nevertheless, remarkable work has been done with much smaller apertures.
- Equatorial mount with slow-motion controls & a clock-drive.
- Quality color filters of known wavelength transmission, plus a variable-density polarizer.
- For achromatic refractors, a filter that suppress the secondary spectrum.
- *Astronomical Almanac* or access to a suitable printed or electronic ephemeris.
- Digital imaging equipment (IR blocking filters are suggested).
- Laptop (PC or Mac) with software for capturing, stacking, manipulation, & processing of images of Saturn.

Keys to Meaningful Results

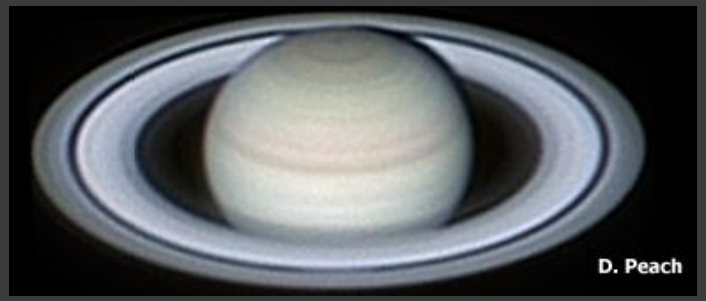
- Keep accurate records of image orientation, date & time (UT), location of the observing site, telescope used, magnifications, filters, etc.
- Use standard Saturn observing forms for recording observations (available for download on the ALPO Website).
- Submit observational data regularly during an apparition (electronic submittal of images & scanned drawings is encouraged).
- Start observing early in the apparition, continue through opposition, & persevere until the planet nears conjunction with the Sun.
- Widely-spaced observations in time, or those that are poorly-planned or lack supporting data, have minimal scientific value.
- Strive for *simultaneous observations* (i.e., independent, systematic studies by two or more observers on the same date & at the same time).

Some Achievements by ALPO Saturn Observers

- Systematic visual observations over many years have shown that distinct belts & zones are not just occasionally seen on Saturn.
- Discrete phenomena are more obvious with color filters & variable-density polarizers.

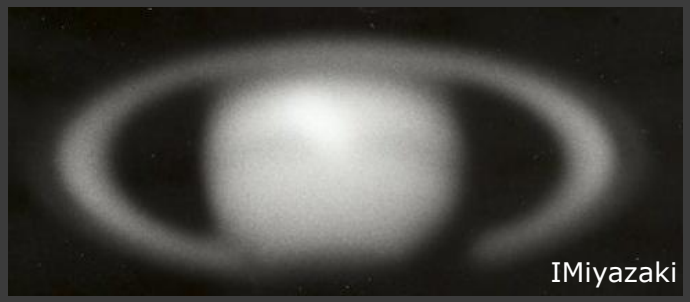


- Cassini's & Encke's divisions are not the only “gaps” in Saturn’s rings (e.g., several "intensity minima" in the rings were routinely seen by amateurs prior to the *Voyager* missions).



- Ring C can be seen as well as imaged at the ansae & in front of the Saturn’s globe with small-to-moderate apertures.

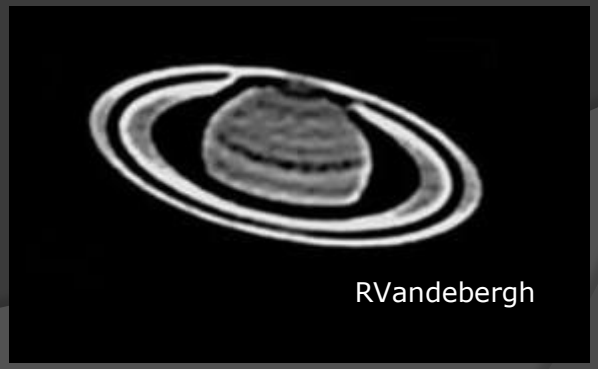
- Analysis of long-term observations of recurring dark features & bright spots identified a pattern for major atmospheric outbursts on Saturn.



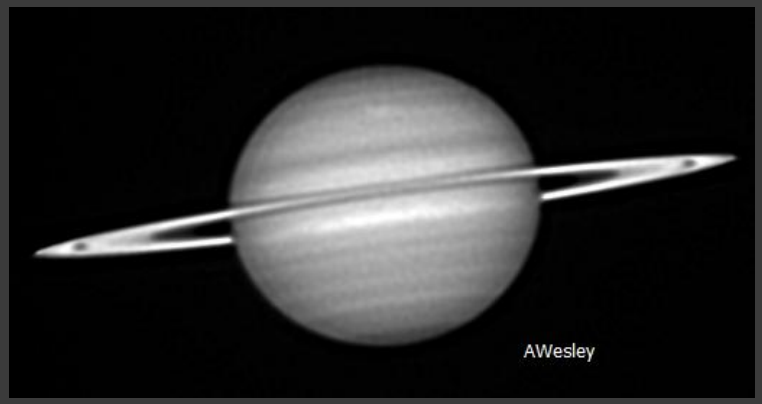
The Great White Spot of 1990

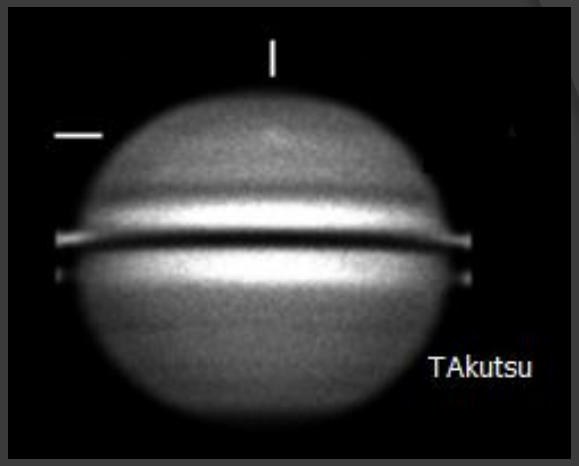
- Analysis of CM data collected for long-enduring spots on Saturn suggests a definite variance in the rotation rates of the SEB & NEB.
- Over a Saturnian year (29.5 Earth-years) belt & zone intensity data reveal a subtle seasonal effect on the planet.
- The tenuous Ring E outside Ring A was seen by amateurs prior to the *Voyager* flybys.
- Amateurs periodically reported dusky radial "spokes" in Ring A & B prior to *Voyager*.

Recent observations of radial ring "spokes"

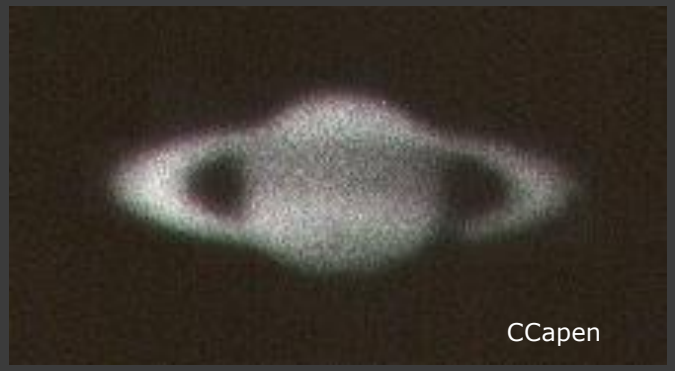


- Digital imaging by skilled observers reveal discrete phenomena on Saturn not always seen visually & which have been used to alert professional astronomers.





- The *bicolored aspect of the rings* & curious *brightness asymmetries around* Ring A have been seen visually as well as captured on film & with digital imagers.

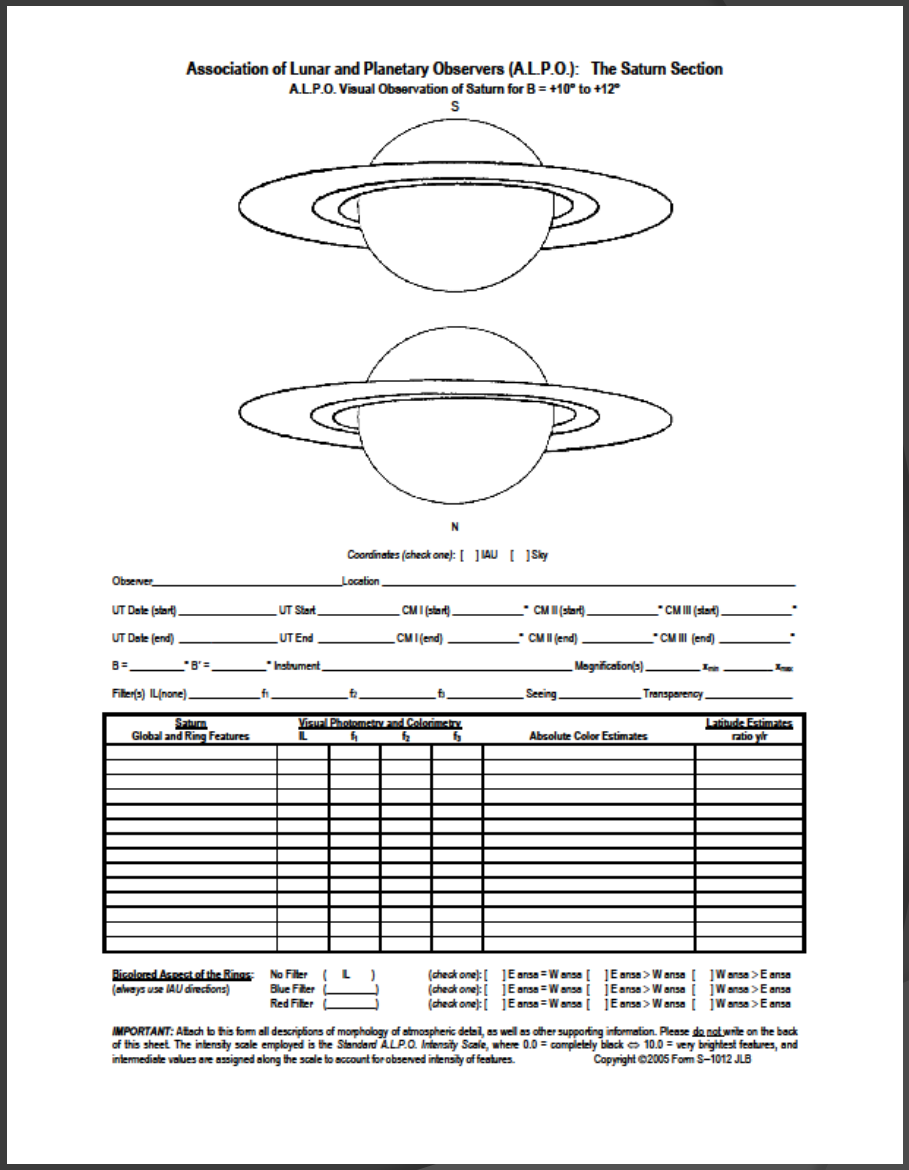


ALPO Saturn Observing Programs

- Visual numerical relative intensity estimates of belts, zones, & ring components in integrated light & with color filters.
- Full-disc drawings of Saturn using standard ALPO observing forms.
- Digital imaging of Saturn's globe, rings, & satellites at various wavelengths.
- Central meridian (CM) transit timings of discrete detail on Saturn's globe.
- Visual estimates & measurements of belt & zone latitudes.
- Visual observations & imaging of "intensity minima" detected in the rings.
- Visual studies & imaging of the bicolored aspect & curious asymmetries in brightness around the circumference of Ring A.
- Accurate timing & imaging of stellar occultations by Saturn's globe & rings.
- Specialized studies of Saturn at small ring inclinations or when they are edgewise to our line of sight (e.g., transits of satellites & their shadows across the globe).
- Visual observations & magnitude estimates of Saturn's satellites.
- Routine descriptive reports to accompany visual observations or images.

Sample ALPO Saturn Drawing Blank

Although regular digital imaging of Saturn is very important, observers ***should not neglect*** to make routine visual numerical relative intensity estimates of globe and ring features.



Association of Lunar and Planetary Observers (A.L.P.O.): The Saturn Section

A.L.P.O. Visual Observation of Saturn for B = +10° to +12°

S

N

Coordinates (check one): [ ] IAU [ ] Sky

Observer_____ Location _____

UT Date (start) _____ UT Start _____ CM I (start) _____° CM II (start) _____° CM III (start) _____°

UT Date (end) _____ UT End _____ CM I (end) _____° CM II (end) _____° CM III (end) _____°

B = _____° B' = _____° Instrument _____ Magnification(s) _____ x_{min} _____ x_{max}

Filter(s) IL(none) _____ f_1 _____ f_2 _____ f_3 _____ Seeing _____ Transparency _____

Saturn Global and Ring Features	Visual Photometry and Colorimetry IL	f_1	f_2	f_3	Absolute Color Estimates	Latitude Estimates ratio y/r

Bicolored Aspect of the Rings: (always use IAU directions)
No Filter (IL) (check one): [ ] E ansa = W ansa [ ] E ansa > W ansa [ ] W ansa > E ansa
Blue Filter (_____) (check one): [ ] E ansa = W ansa [ ] E ansa > W ansa [ ] W ansa > E ansa
Red Filter (_____) (check one): [ ] E ansa = W ansa [ ] E ansa > W ansa [ ] W ansa > E ansa

IMPORTANT: Attach to this form all descriptions of morphology of atmospheric detail, as well as other supporting information. Please do not write on the back of this sheet. The intensity scale employed is the *Standard A.L.P.O. Intensity Scale*, where 0.0 = completely black <> 10.0 = very brightest features, and intermediate values are assigned along the scale to account for observed intensity of features.

2004-11 Professional-Amateur Cassini Observing Patrol

- The Saturn Pro-Am effort began on April 1, 2004 when *Cassini* started observing the planet at close range.

- Observers are urged to participate in the following projects as the *Cassini* mission continues this apparition & beyond:

  - Using classical broadband filters (Johnson UBVRI system) on telescopes with suggested apertures ≥ 31.8cm (12.5in), observers should image Saturn with a 890nm narrow band methane (CH_4) filter.

  - Observers should image Saturn every clear night in search of individual features, their motions and morphology. Resulting data can serve as input to the *Cassini* imaging system, thereby suggesting where interesting (large-scale) targets exist.

  - Suspected changes in belt & zone reflectivity (i.e., intensity) & color are useful, so *visual observers can play a vital role by making careful visual numerical relative intensity estimates in Integrated Light (no filter) & with color filters of known transmission*.

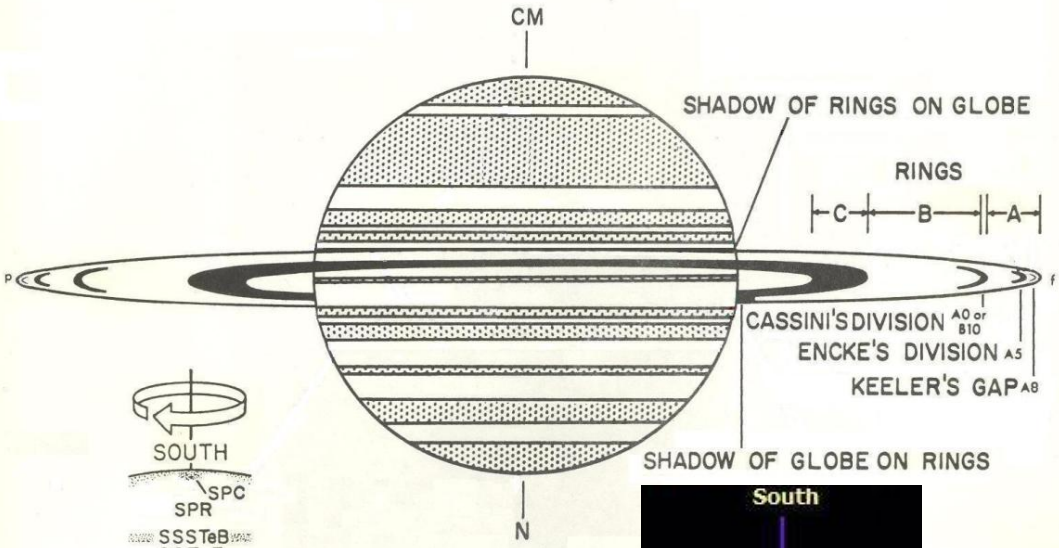
  - The *Cassini* team can combine ALPO images with data from the *Hubble Space Telescope* & from ground-based observatories.

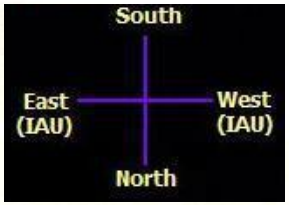
  - Observations should be sent to the ALPO Saturn Section for prompt forwarding to the *Cassini* team.

Geocentric Phenomena in UT for Saturn

	2010-11 Apparition	2011-12 Apparition
• Conjunction	2010 Oct 01^{d} UT	2011 Oct 13^{d} UT
• Opposition	2011 Apr 04^{d}	2012 Apr 15^{d}
• Conjunction	2011 Oct 13^{d}	2012 Oct 25^{d}
Opposition Data:		
Equatorial Diameter Globe	19.3″	19.0″
Polar Diameter Globe	17.5″	16.9″
Major Axis of Rings	43.8″	43.0″
Minor Axis of Rings	6.6″	28.6″
Visual Magnitude (m_v)	+0.4m_v	+0.2m_v
B =	+8.6^{o}	+13.7^{o}
Declination	–2^{o} 57′ 15.1″	–7^{o} 42′ 00″

Standard Nomenclature for Saturn





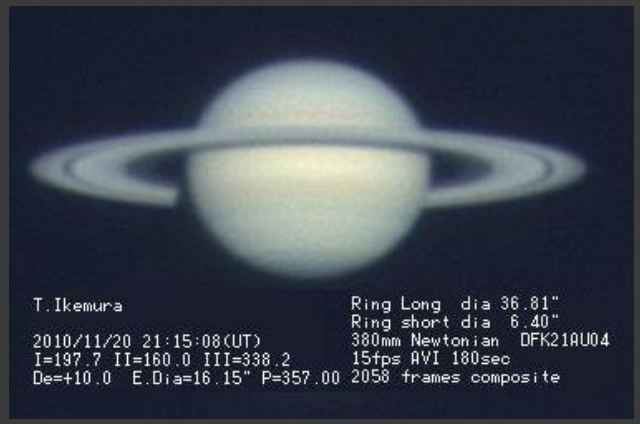
Direction of Rotation

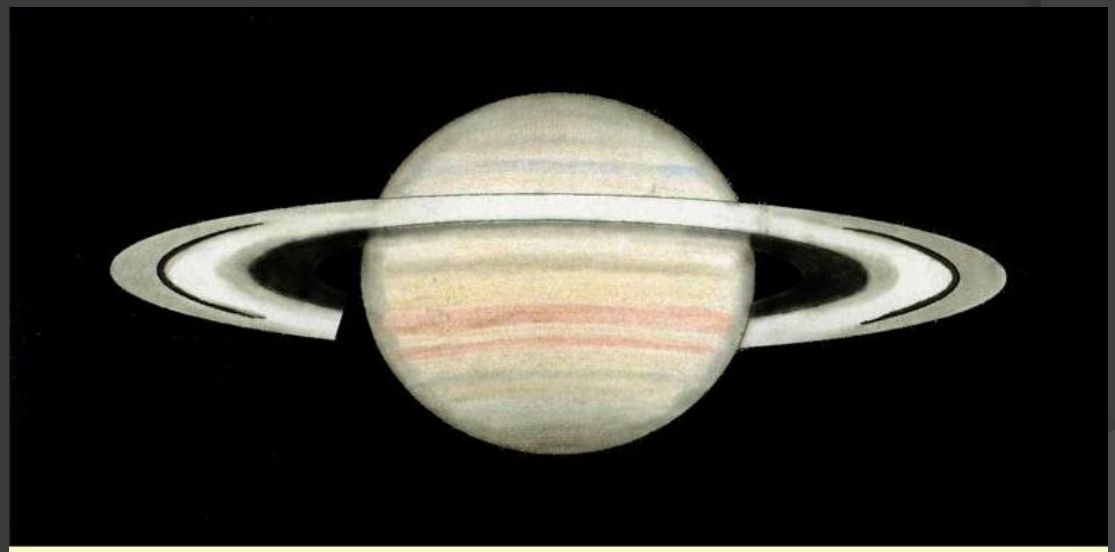
B = +9.0°

Saturn has 3 systems of rotation:

System I	10h 14m 13s (Equatorial regions of the Globe - EZ, EB, SEB, NEB)
System II	10h 38m 25s (Regions North or South of System I)
System III	10h 39m 22s (Radio rate)

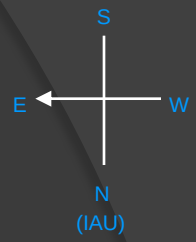
Pre-Opposition Views of Saturn in 2010-11





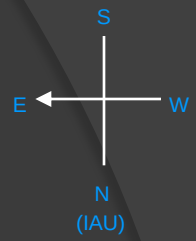
Disk Drawing: 0644UT, 167x and 250x, Seeing= AIII-IV, Tr= Good
CM1: 142.5 CM2: 309.1 CM3: 67.8

2011 January 09, Start: 0615UT Finish: 0644UT, Seeing=AIII-IV
203mm Newtonian Reflector, 167x and 250x, B=10.2 Ds= 7.7
Disk Diameter= 17.4", Ls= 17. Paul G. Abel, Leicester UK



Shadow of the Globe on the Rings is toward the East (IAU) prior to Opposition

More Pre-Opposition Views of Saturn in 2010-11

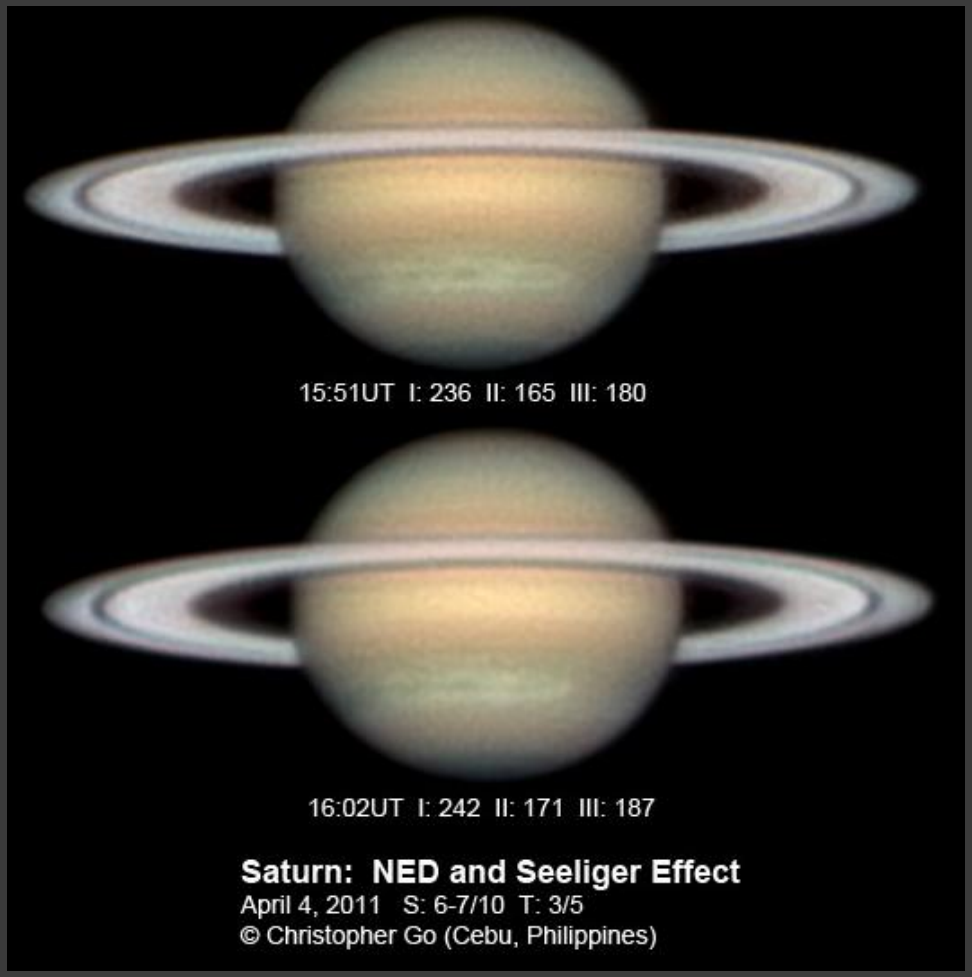


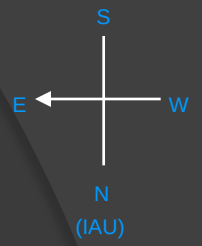
Shadow of the Globe on the Rings is toward the East (IAU) prior to Opposition

February 24th 2011, 18:31 UTC, CMIII 326 degrees, Dia 18.8 arc sec's
Ring Op Earth 9.8 degrees, Alt 58 degrees 13 min's, seeing 7 to 8/10

RGB 16" F 4.5 Newt working at F 23.7 PGR Flea3
Imaged at Broken Hill Australia by Trevor Barry

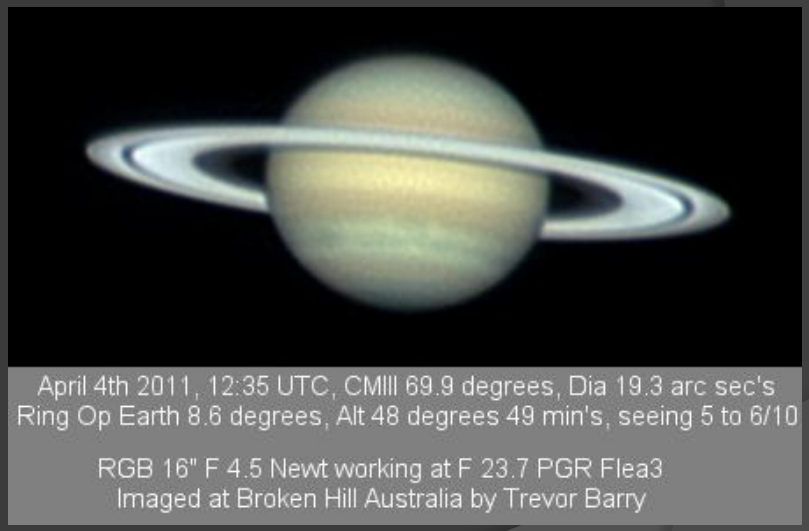
Saturn at Opposition in 2010-11





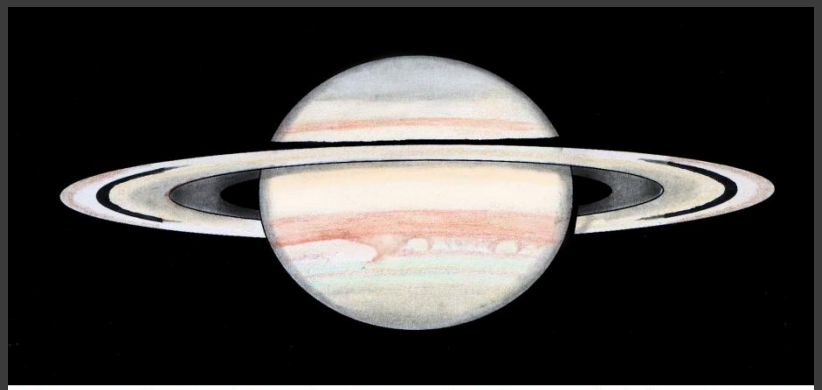
2010-11 Opposition Data:

2011 Apr 04^{d} UT
Eq Dia Globe = 19.3”
Po Dia Globe = 17.5”
Maj Axis Rings = 43.8”
Min Axis Rings = 6.6”
Visual Magn = +0.4
B = +8.6^{o}
Declination = –2^{o} 57′ 15.1″

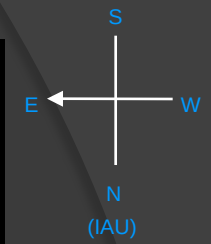


The Seeliger Opposition Effect is an apparent brightening of Saturn's rings during a very short interval near opposition. It is most likely due to coherent back-scattering of μ-sized icy particles in the rings when the phase angle between Sun-Saturn-Earth is <0.3°.

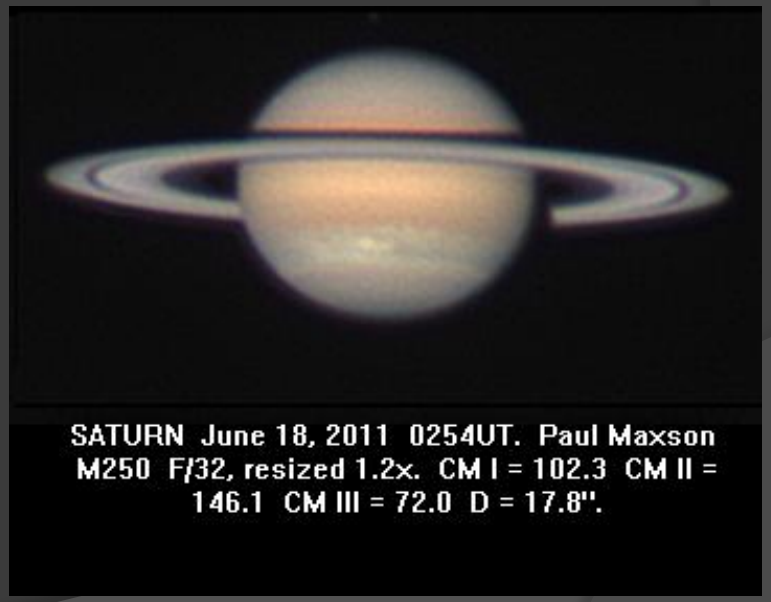
Post-Opposition Views of Saturn in 2010-11



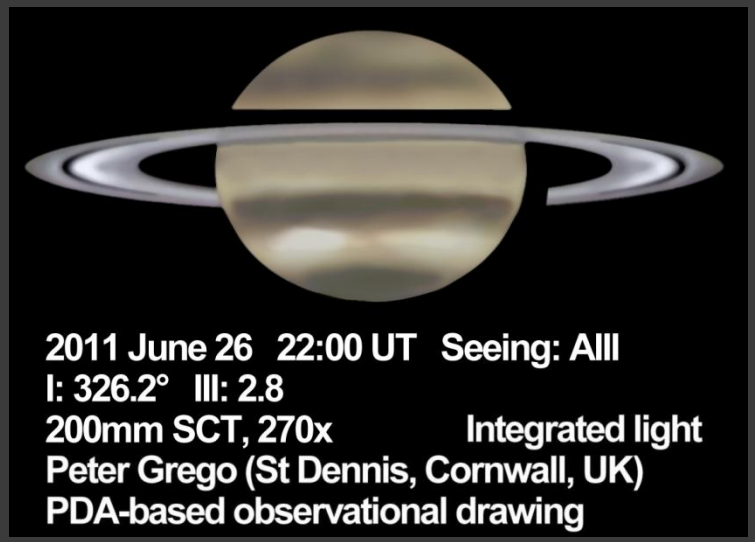
2011 April 22nd-23rd, Start: 2132UT Finish: 0021UT
203mm Newtonian Reflector, S:AII-IV, Transp: Average
B= 8.0, Ds= 9.2, Disk Diameter= 19.2", Ls= 21
Paul G. Abel, Leicester UK

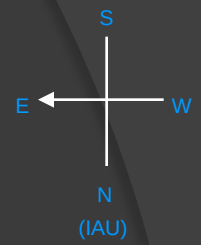


Shadow of the Globe on the Rings is toward the West (IAU) following Opposition

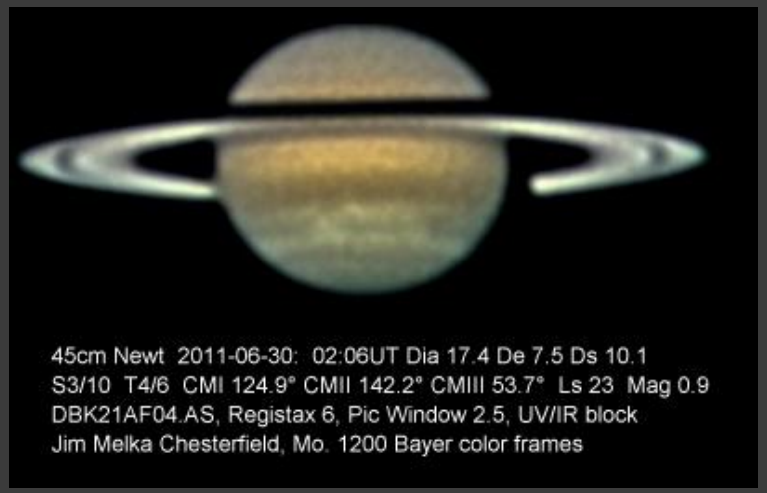


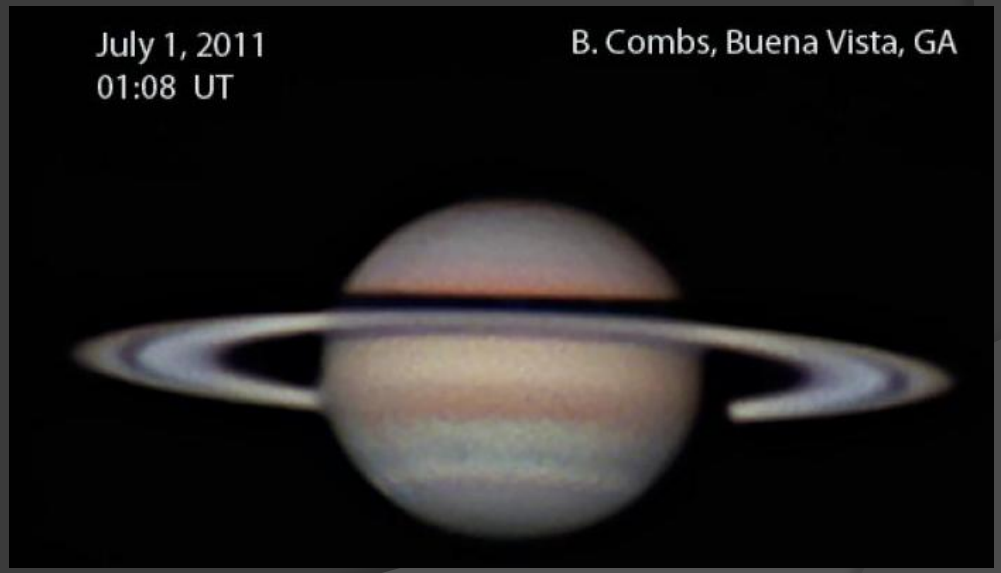
More Post-Opposition Views of Saturn 2010-11





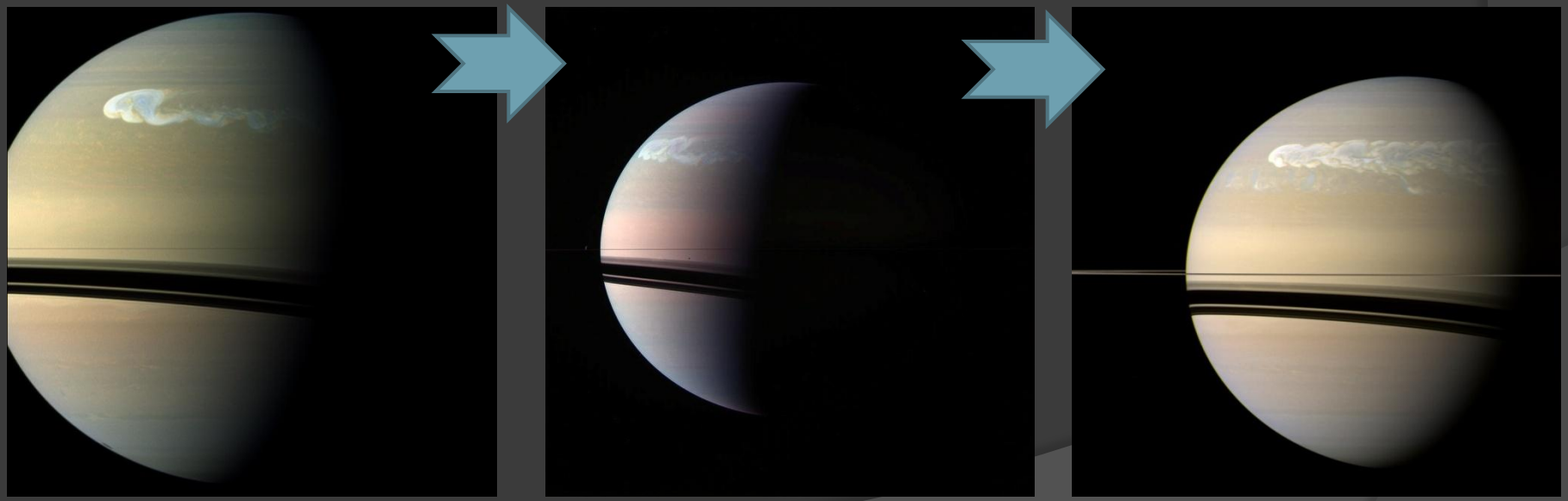
Shadow of the Globe on the Rings is toward the West (IAU) following Opposition





The Great NTrZ Storm of 2010-11

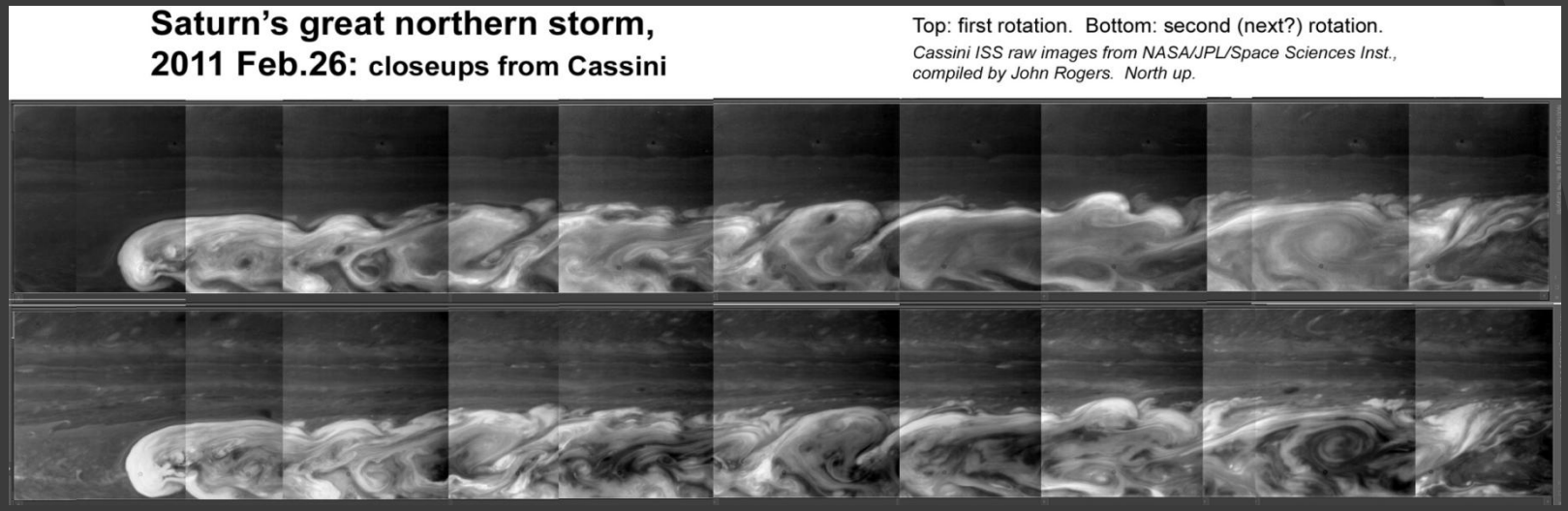
- First detected by *Cassini* at 23:26UT on December 5, 2010 at 35°N Saturnigraphic latitude with progressive growth:
  - On December 5th the storm spanned 1,300km (800mi) N to S (latitudinally) & 2,500km (1,600mi) E to W (longitudinally).
  - By December 24th the storm grew to 10,000km (6000mi) latitudinally & extended nearly 1/3 the way around the planet, a distance of 100,000km (62,000mi) longitudinally.
  - By the end of January & February 2011, the storm has swollen in latitudinal extent to 15,000km (9,000mi) around +43 & longitudinally the "tail" had encircled the entire planet.
  - The storm's latitudinal expansion has progressively occupied the region between Saturnigraphic latitude 35°N & 40°N, and the storm is still active.

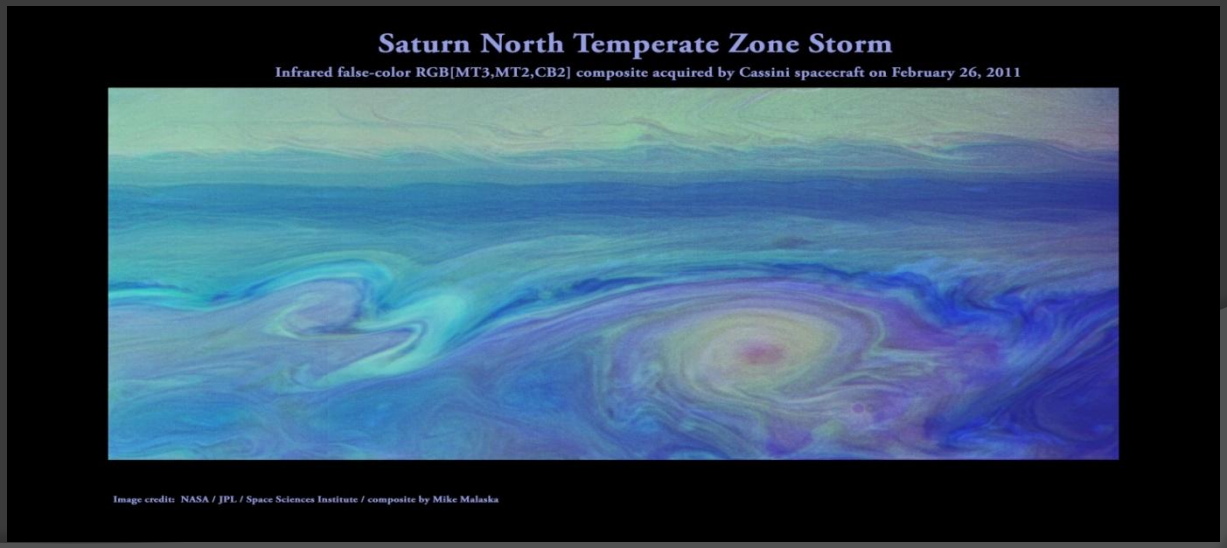


Images courtesy of NASA's Cassini Mission

The Great NTrZ Storm of 2010-11

- White spots arise as columns of material break through the upper NH_4-ice cloud layer & spread out.
- Complex swirls intermix with darker material dredged up from deeper down in Saturn's atmosphere.





The Great NTrZ Storm of 2010-11

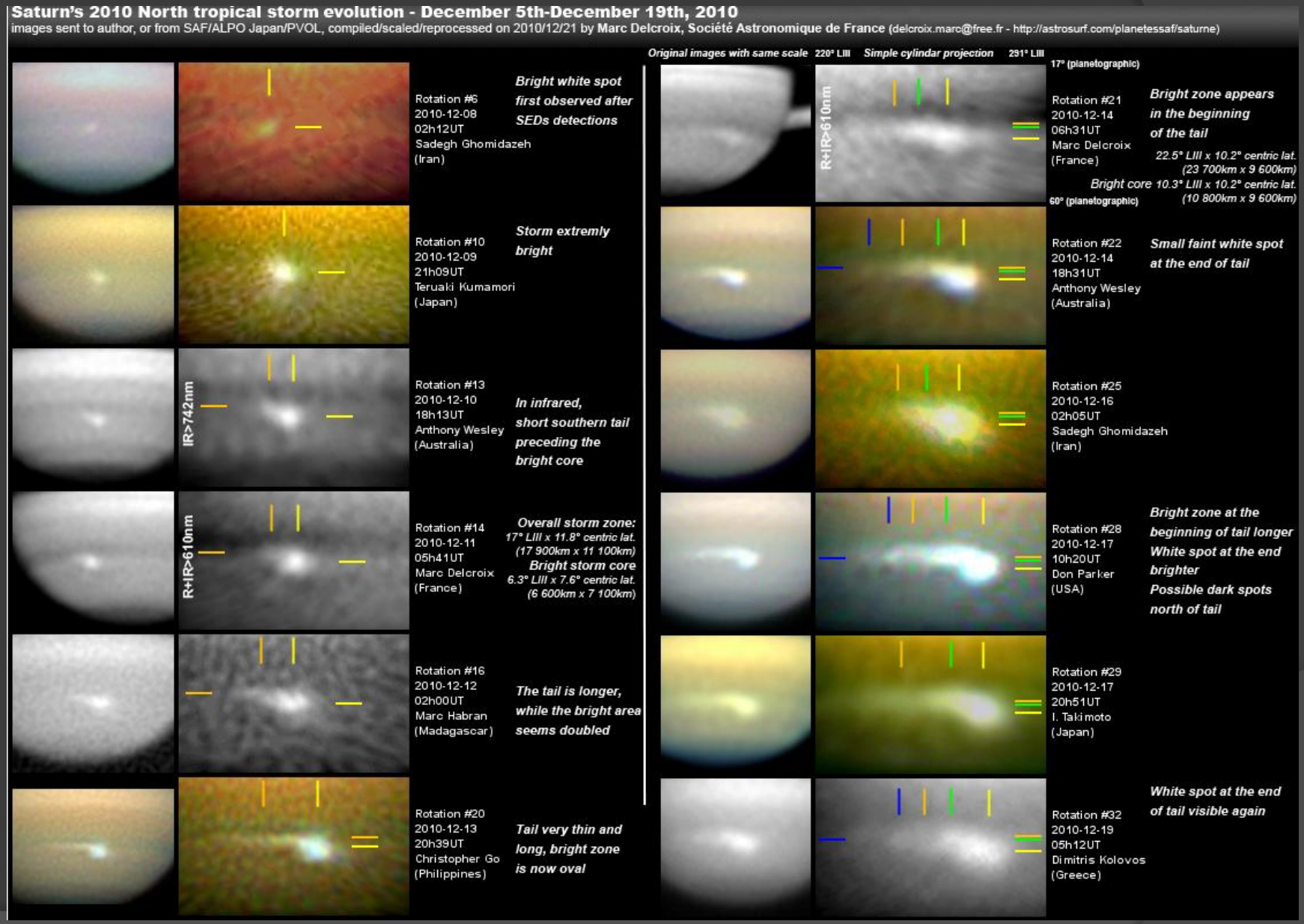
- The NTrZ storm is 500 times larger than the those seen by *Cassini* in late 2009 into early 2010.
- Prior to the August 2009 vernal equinox, when the Sun was shining on the planet's southern hemisphere, the location of all observed storm activity was in the STrZ near 35°S Saturnigraphic latitude, referred to by *Cassini* scientists as "storm alley".
- Now that the Sun is north of the rings, it is early spring in Saturn's northern hemisphere.
- The NTrZ storm's emergence at 35°N Saturnigraphic latitude shows how shifting seasons & solar illumination can dramatically stir up weather on Saturn.
- The shadow cast by Saturn's rings has a strong seasonal effect related to the varying position of the ring shadow.
- It is a continuing mystery why Saturn stores energy for decades, then releases it all at once (unlike Jupiter & Earth, which have numerous storms occurring at any one time).
- Why the obvious hemispheric symmetry in storm eruption occurs is unknown.
- The NTrZ storm is the largest & most intense ever recorded by the *Voyager* & *Cassini* spacecraft. Observers will recall the Great White Spot imaged by the *Hubble Space Telescope (HST)* in 1990.
- Lighting flash rates associated with the NTrZ storm are 10 times more frequent than during other storms monitored since *Cassini* arrived at Saturn in 2004.
- There appears to be a link between lightning storms on Saturn & the emergence of Ring B spokes.

The Great NTrZ Storm of 2010-11

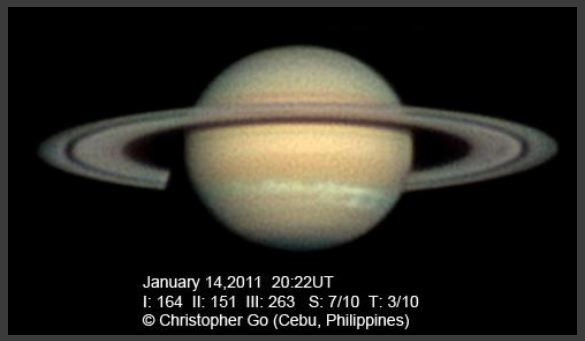
- Soon after the first detection of the storm last December, the *Cassini* team issued an appeal to amateur astronomers worldwide to collect as many images as possible.
- Amateur's responded right away, submitting myriad images throughout the apparition, helping *Cassini* scientists track the storm as it has developed over time.
- The first image received by the ALPO Saturn Section occurred on December 10, 2010.

- The next several slides present chronological samples of ALPO observations of this phenomenal NTrZ storm from early December 2010 up to the present.

The Great NTrZ Storm of 2010-11

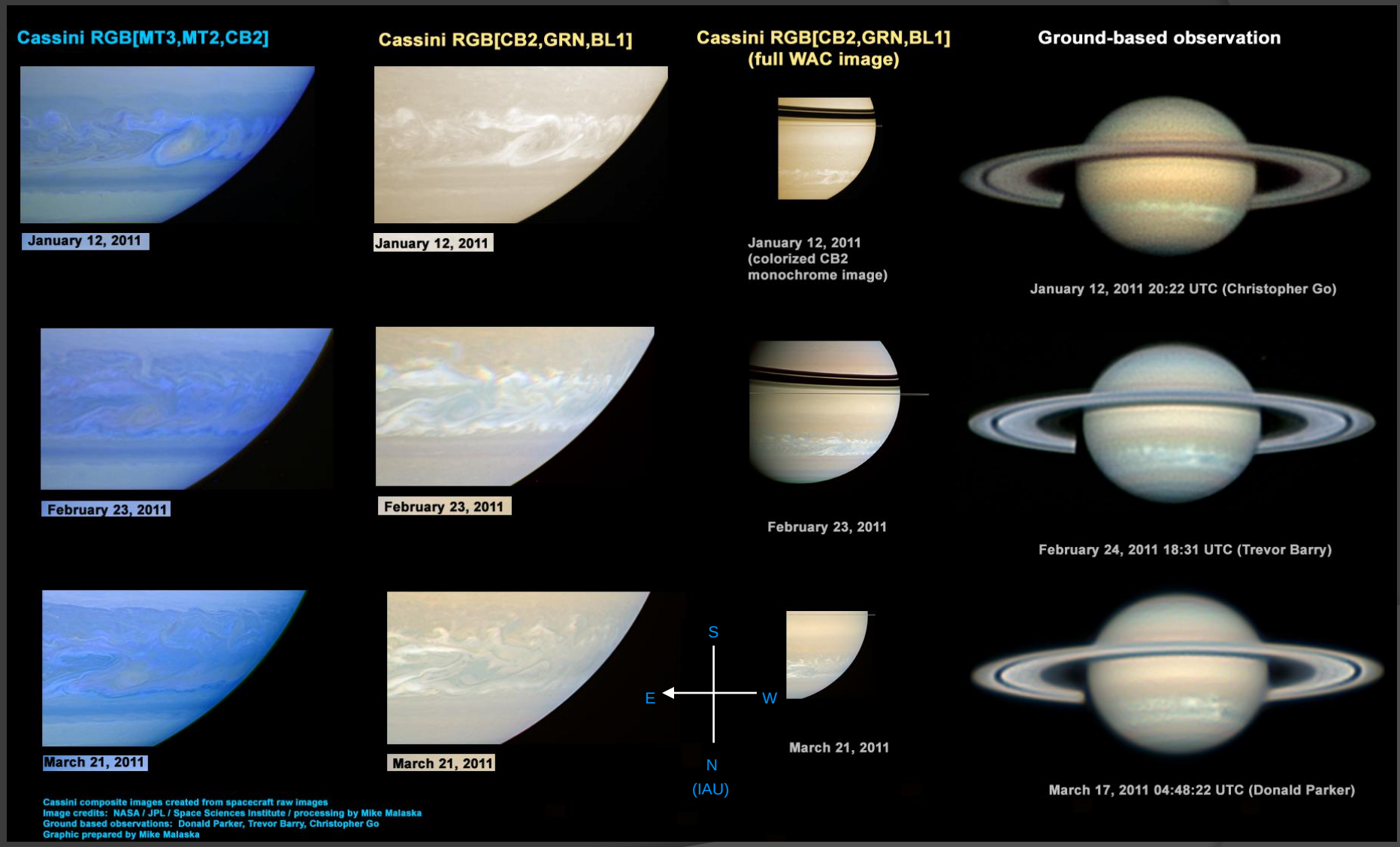


The Great NTrZ Storm of 2010-11

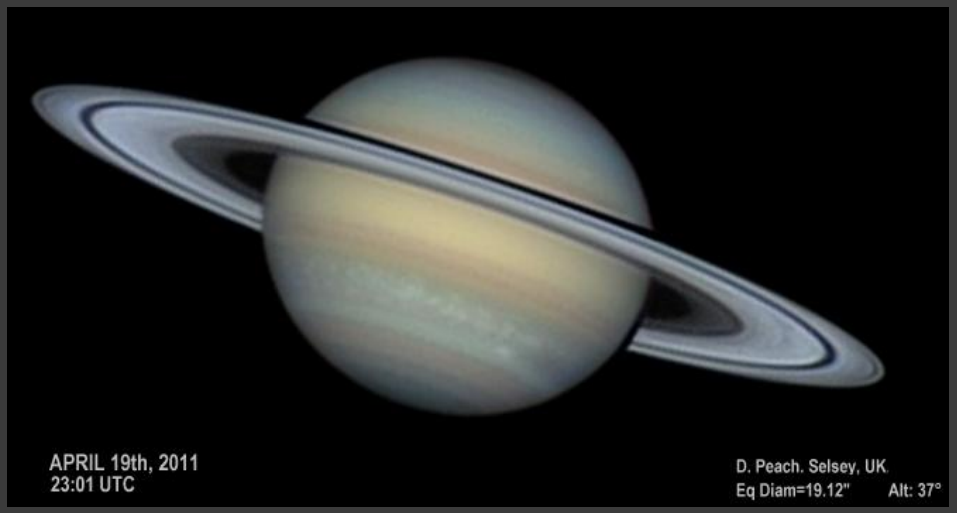


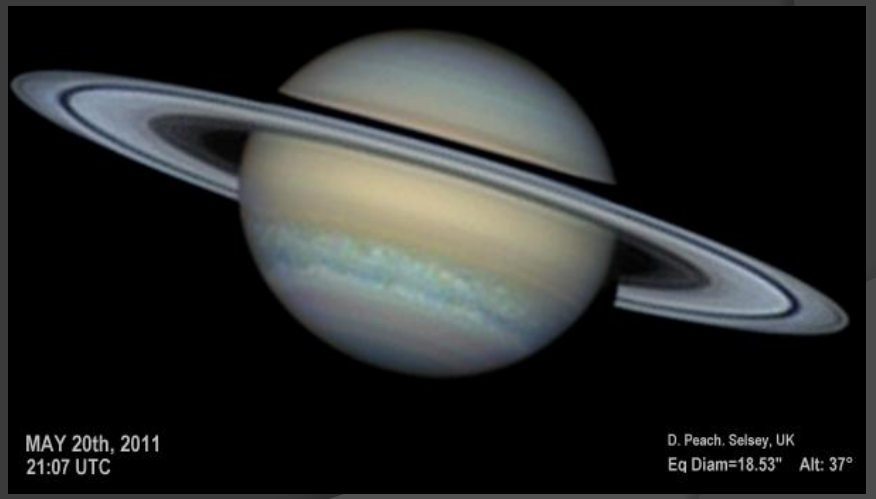
The Great NTrZ Storm of 2010-11

Comparison of *Cassini* images with ALPO Ground-based images January thru March 2011

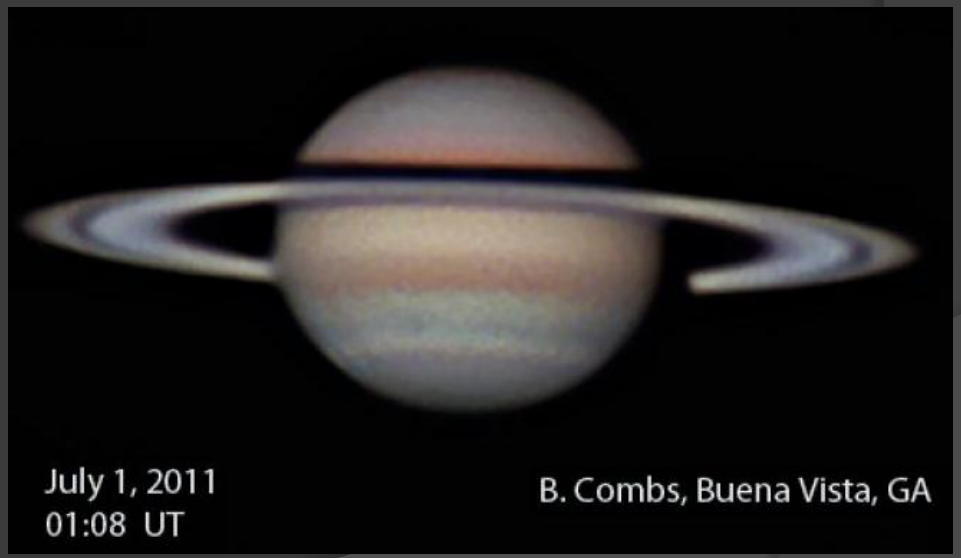


The Great NTrZ Storm of 2010-11

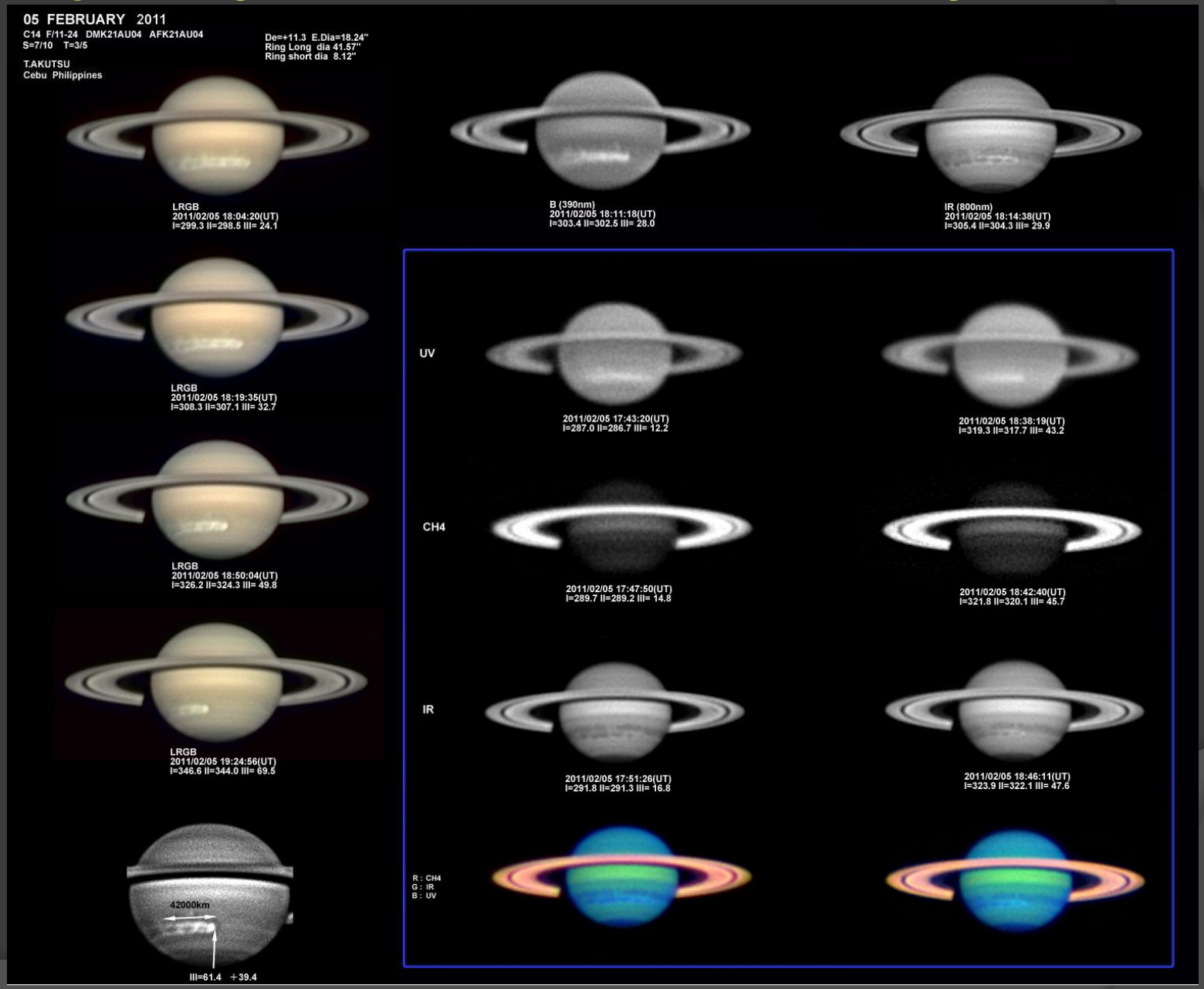




The Great NTrZ Storm of 2010-11



Sample Images of Saturn at Various Wavelengths in 2010-11



Getting Ready for 2011-12

Saturn entered conjunction with the Sun on October 13, 2011.

Observers should send their images, drawings, descriptive reports, & other data to the ALPO Saturn Section as soon as possible so that preparation of the 2010-11 apparition report can begin.

In early November early risers should be able to see Saturn in the morning sky just before sunrise.

More About How to Observe Saturn

Saturn and How to Observe It is a comprehensive guide to ALPO Saturn observing programs and techniques.